

University of Northern Iowa

UNI ScholarWorks

---

Fall 2019 - Chemical Analysis Class Projects

Chemical Analysis Class Projects

---

Fall 2019

## NIR Mapping of the Mastodon Tusk Layers

Carli Jo Russenberger

University of Northern Iowa, russenbc@uni.edu

Copyright ©2019 Carli Jo Russenberger

Follow this and additional works at: [https://scholarworks.uni.edu/chemanaly\\_fa2019](https://scholarworks.uni.edu/chemanaly_fa2019)

 Part of the [Chemistry Commons](#)

*Let us know how access to this document benefits you*

---

### Recommended Citation

Russenberger, Carli Jo, "NIR Mapping of the Mastodon Tusk Layers" (2019). *Fall 2019 - Chemical Analysis Class Projects*. 1.

[https://scholarworks.uni.edu/chemanaly\\_fa2019/1](https://scholarworks.uni.edu/chemanaly_fa2019/1)

This Open Access Poster is brought to you for free and open access by the Chemical Analysis Class Projects at UNI ScholarWorks. It has been accepted for inclusion in Fall 2019 - Chemical Analysis Class Projects by an authorized administrator of UNI ScholarWorks. For more information, please contact [scholarworks@uni.edu](mailto:scholarworks@uni.edu).



# NIR Mapping of the Mastodon Tusk Layers

Carli Russenberger, University of Northern Iowa  
Department of Chemistry and Biochemistry

## Background

This tusk was unearthed in September of 1933 in the town of Hampton, Iowa. About two feet from the proximal end, the tip broke upon extrication. In order to preserve this archaeological finding, many layers of lacquers, plasters, and varnishes were applied.<sup>3</sup> The layers of preservation are not well identified, as well as the timing of application.

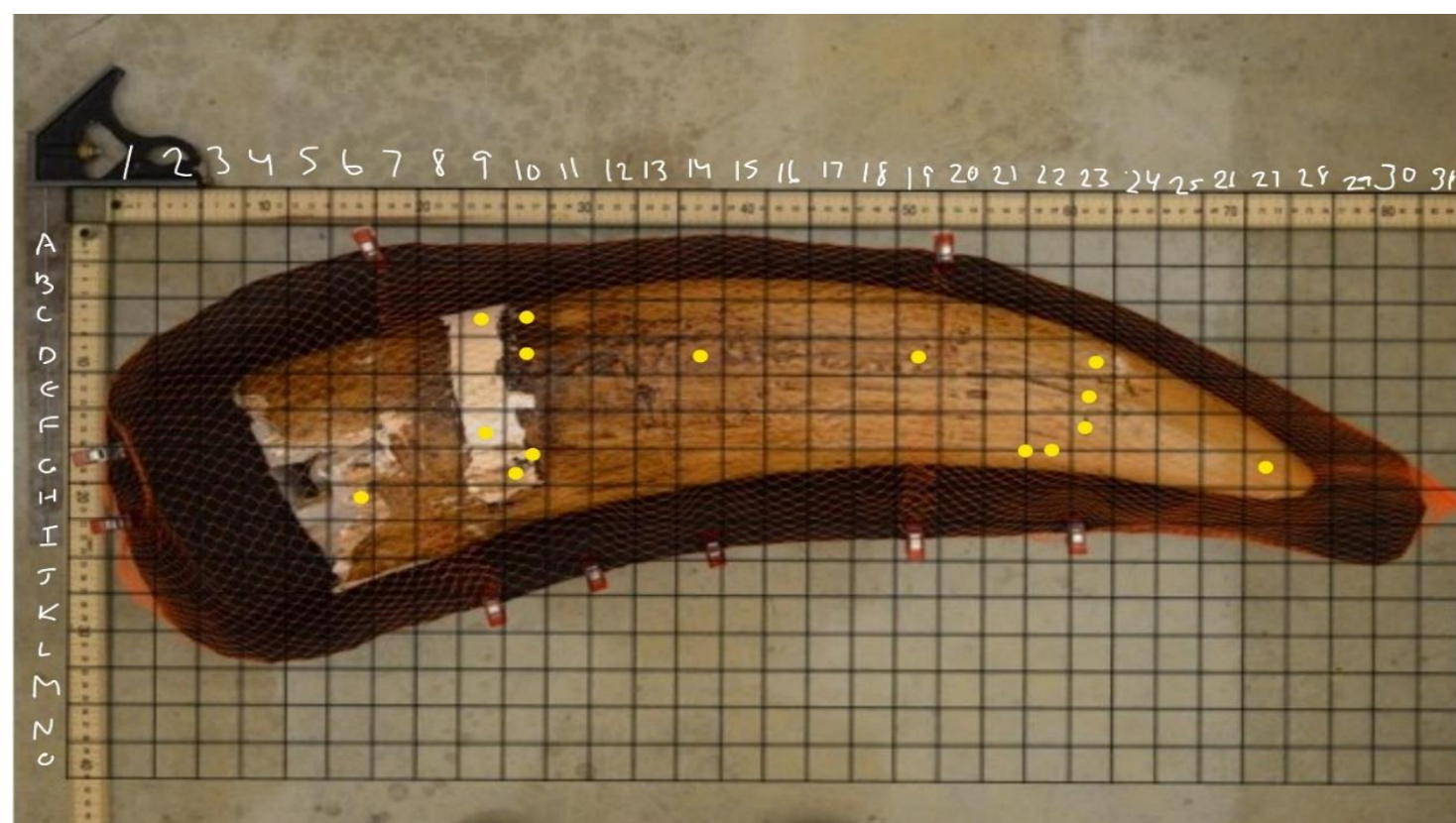


By using the Near-Infrared (NIR) technique, infrared light is applied to the tusk and wavelengths are absorbed. The absorbances can help determine the functional groups of the restoration materials in the NIR range of 4,000 to 10,000 wavenumbers.

The objective of the experiment is to provide guidance towards the identification of preservation techniques. By identifying the compounds, a more accurate timeline of preservation application can someday be composed.

## Methodology

- Orange netting was purchased, placed around the tusk, and clipped into place on the black base
- A picture was taken of the tusk and ruler guidelines, and an overlay grid was applied
- The yellow dots on the image mark the locations in which data was collected.
- The iS50 NIR module with the SabIR probe was used to collect absorbance corresponding to wavelengths in the NIR region. The probe was held at a 45° angle to the tusk, with the tip of the probe gently touching the tusk. The data was collected.



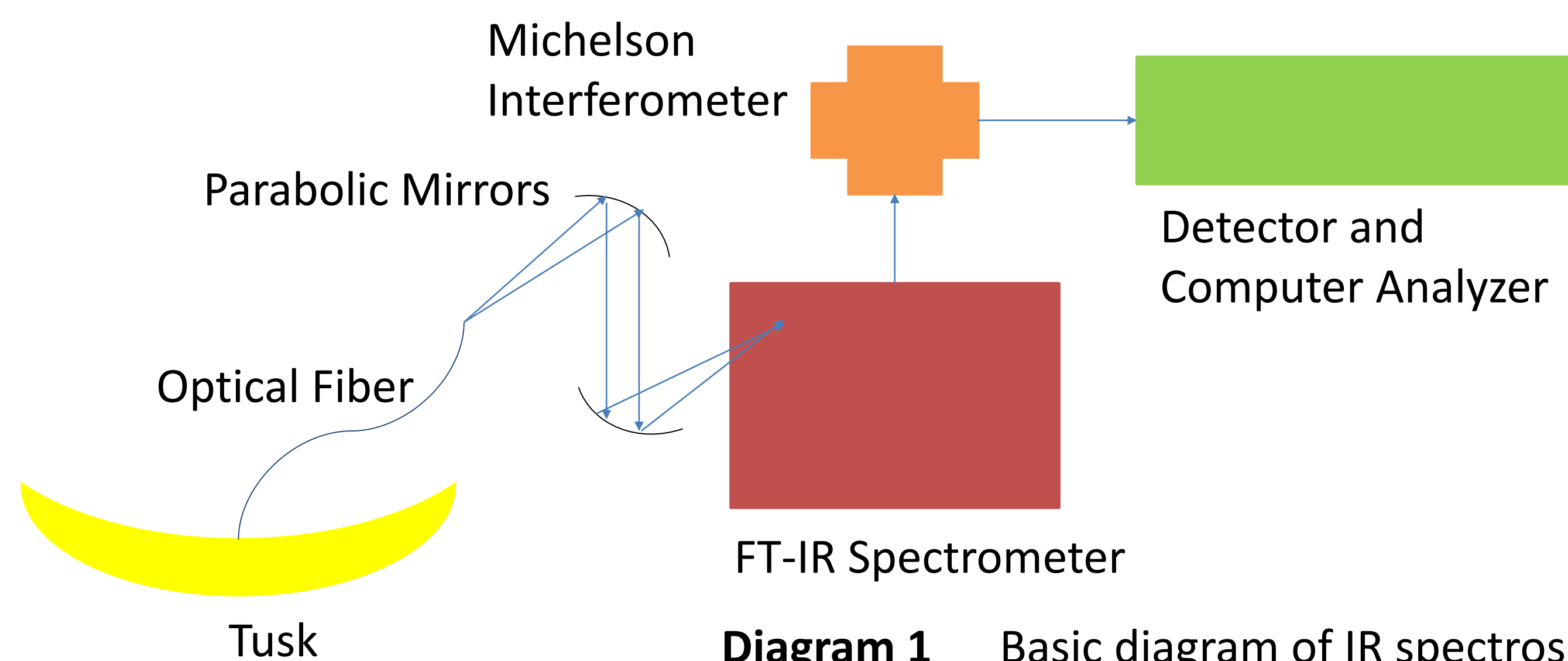
**Image 1** Tusk with grid and data markings



**Image 2** Using the SabIR probe on the tusk

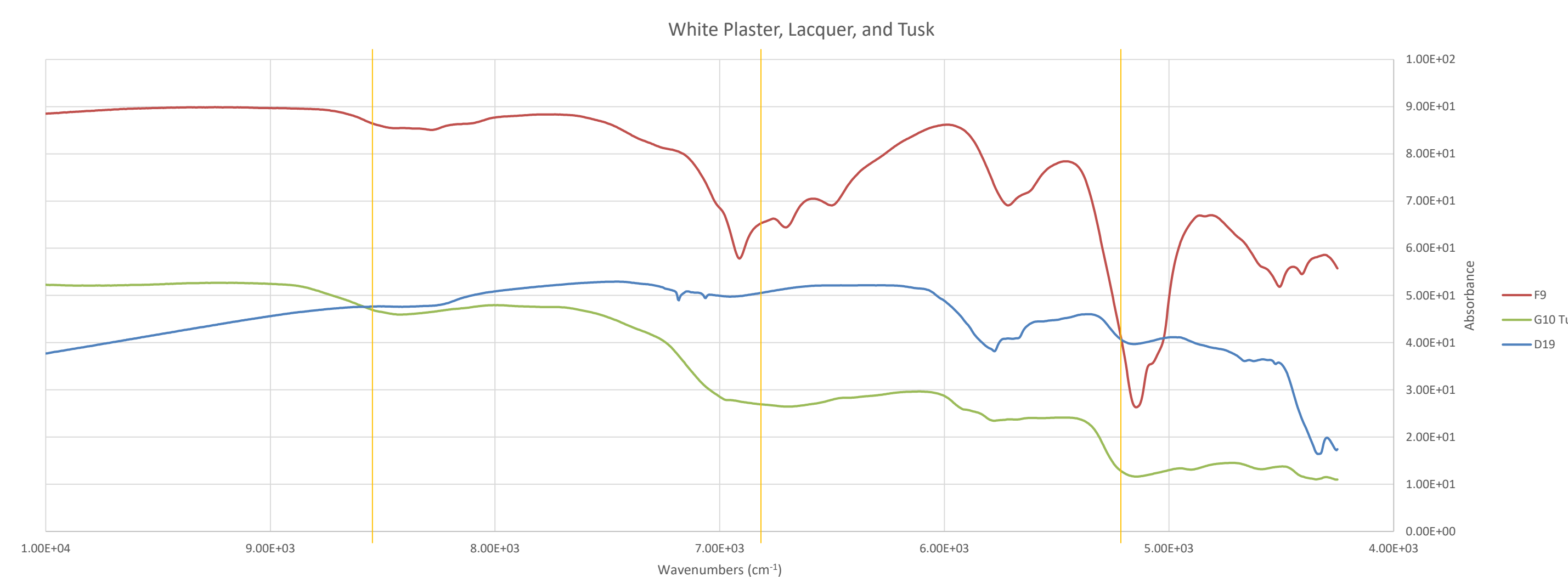
## Instrumentation

- NIR works by illuminating the substance with broad-wavelength near-infrared light.
- Light is absorbed by the tusk sample. Intensity of the absorbance peaks is relative to the functional groups and color intensity apparent in the molecule.
- Background light intensity is measured before each sample absorbance.
- NIR light vibrates and stretches bonds within the molecule. Absorbance bands are overtones or combinations of fundamental stretching vibrational bands.<sup>5</sup>

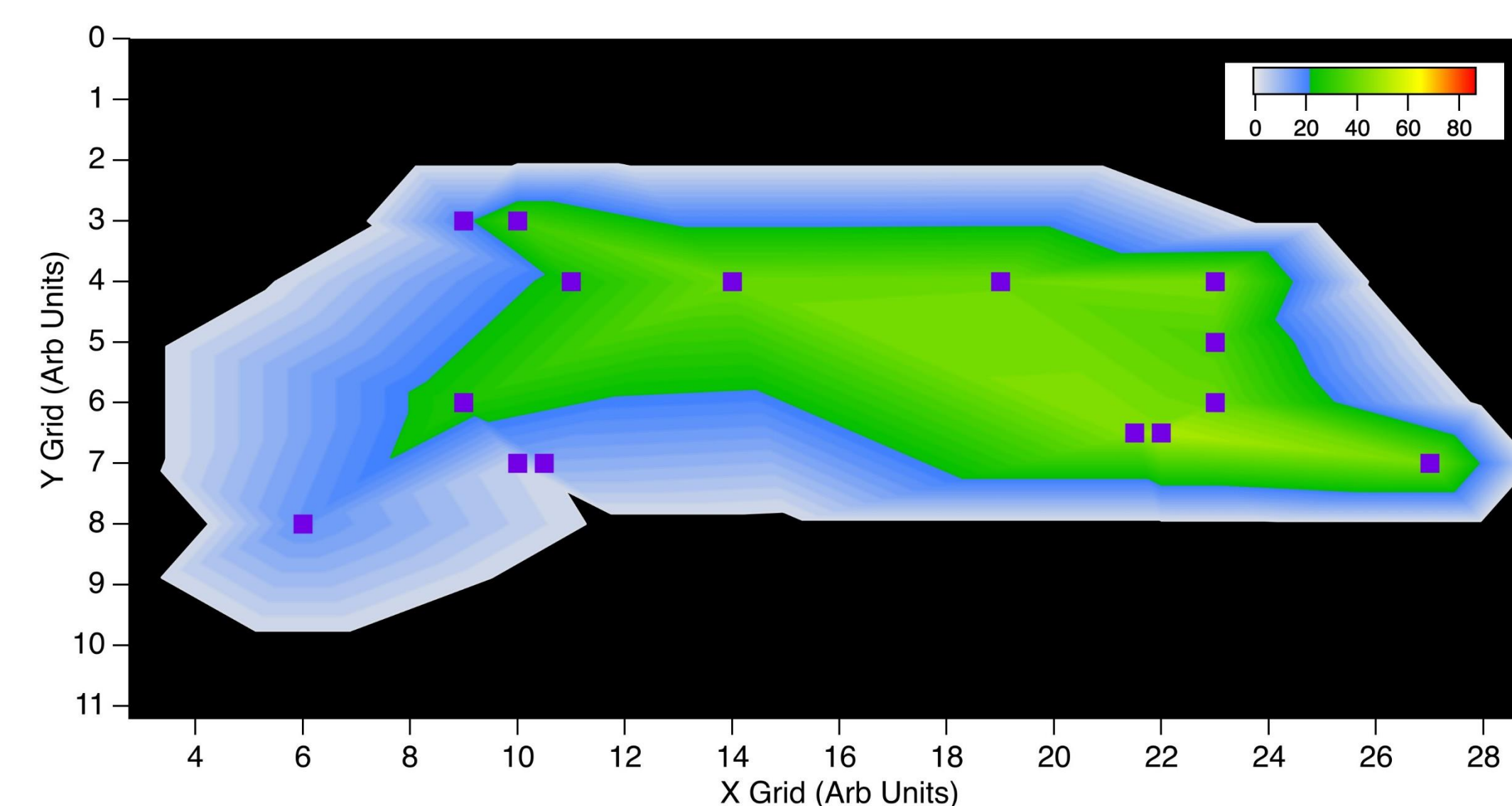


**Diagram 1** Basic diagram of IR spectroscopy

## Results

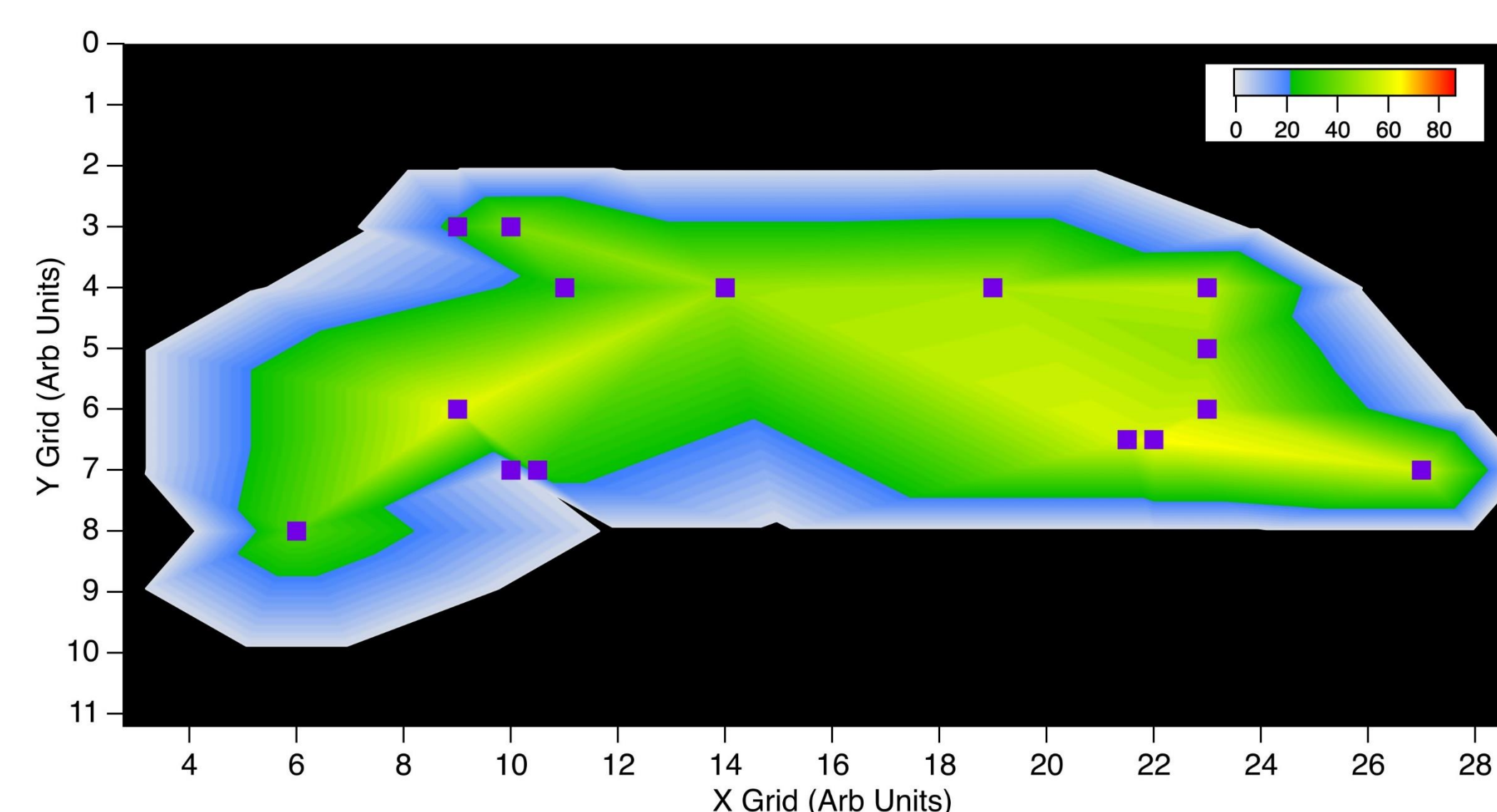


**Graph 1** NIR data plots for the white plaster, lacquer, and tusk materials. The orange vertical lines correspond to the wavenumbers of the contour plots below

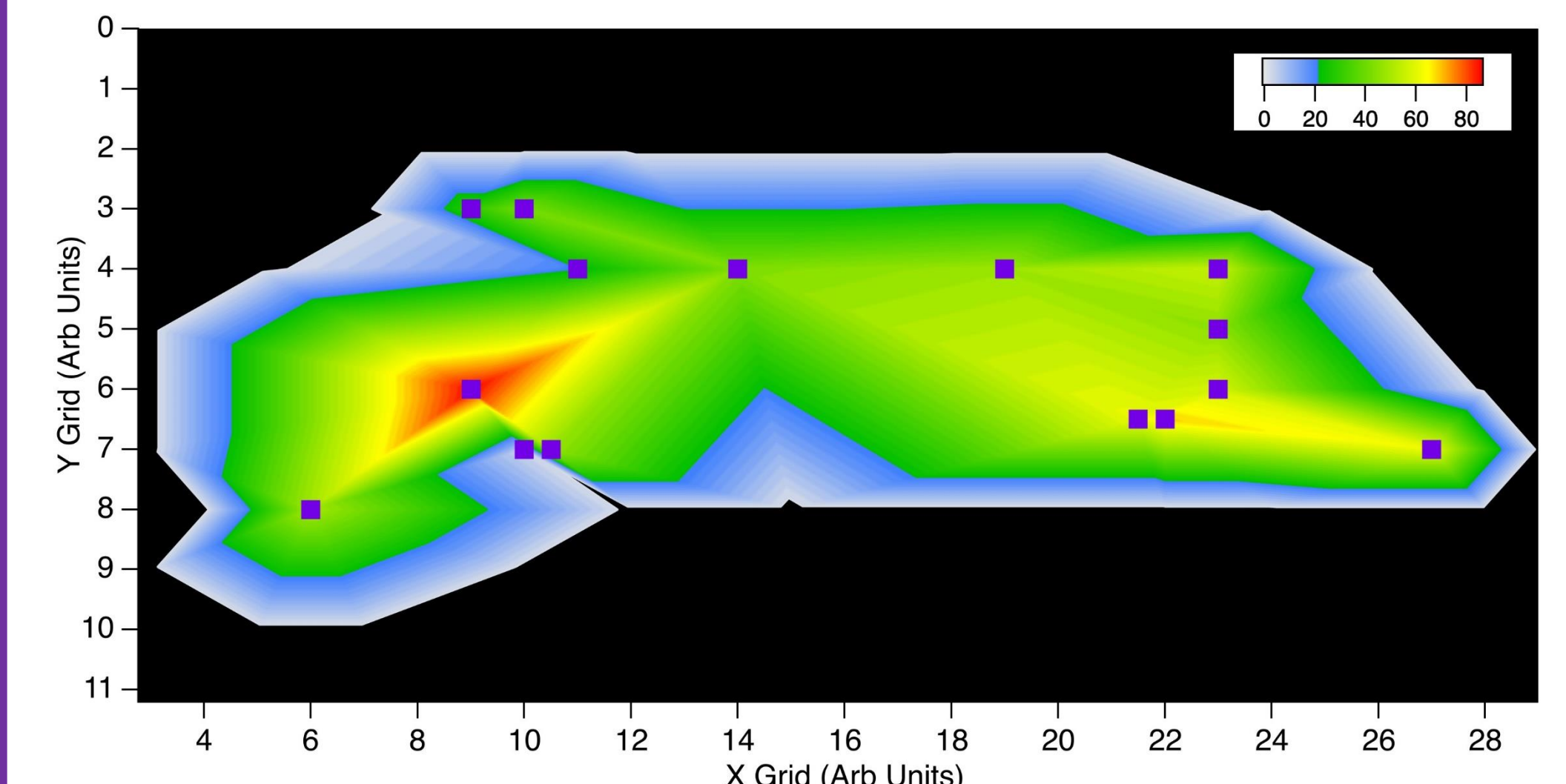


**Graph 2** Contour plot at 5200 cm<sup>-1</sup>. The color scale is in % reflectance

**Graph 3** Contour plot at 6800 cm<sup>-1</sup>



## Results



**Graph 4** Contour plot at 8500 cm<sup>-1</sup>

- Overtone and combination bands are likely to be found in the fingerprint region of NIR
- Contour plots are low spatial resolution maps displaying where different chemical structures are located across the tusk

## Conclusions

- Functional groups absorb at different wavelengths and the intensity is dependent on molecule concentration
- Low spatial resolution maps display functional group structure intensities across the tusk
- High spatial resolution maps are needed to more accurately determine location of chemical structures across the tusk
- NIR overtone and combination band peak and intensity data can be combined with other techniques to identify chemical structures of preservation materials
- Eventually, a more accurate timeline of application can be identified

## Acknowledgements

Thank you to:  
 • Roy J. Carver Charitable Trust  
 • UNI Museum  
 • Joshua Sebree, PhD

## References

- iS50 NIR Module User Guide. Nicolet iS50 FT-IR Spectrometers 2012, 1–58
- Iowa State Teachers College, "Mastodon Tusk [UNI Museum Inventory Description]" (1966). Mastodon Tusk Background Documents. 2.
- Cable, Emmett J., "Hampton Tusk of Mastodon" (1934). Mastodon Tusk Background Documents. 3.
- Francis M.P. Howie (1984) Materials used for conserving fossil specimens since 1930: a review, Studies in Conservation, 29:sup1, 92-97, DOI: 10.1179/ sic.1984.29. Supplement-1.92
- Davies, A. M. C. Introduction to NIR Spectroscopy. <http://www.impublications.com/content/introduct ion-nir-spectroscopy-0> (accessed Sep 20, 2019).